

CLAIMS

1. An improved feed and control system for an internal combustion engine able to be fed with one or other of two fuels such as petrol and liquid gas or petrol and methane, said engine comprising a plurality of first members (26) for introducing a first fuel into corresponding explosion chambers and a plurality of second members (6) for introducing the second fuel into said explosion chambers, said first introduction members (26) being commanded and controlled by a control unit (8) which, on the basis of preselected parameters, acts on said first members (26) such as to achieve optimum engine operation, said control unit (8) also commanding and controlling the plurality of said second introduction members (6) which feed the second fuel to the respective explosion chambers, said unit (8) hence being the only unit for controlling the engine operation, independently of whether it is operated with the first or with the second fuel, characterised in that regulator and control means (11, 21) are provided to regulate and control a physical characteristic of said second fuel during its feed to said plurality of second members (6) for its introduction into the explosion chambers in such a manner that the times for introducing said second fuel into these latter are equal to the times for introducing the first fuel into said explosion chambers, this enabling said control unit (8) to command said second introduction members (6) with the same mode of activation used to command the aforesaid first introduction members when under the same engine utilization conditions.

2. A system as claimed in claim 1, characterised in that the regulator and control means comprise regulator means (11) positioned in a conduit (3) for feeding the second fuel to said second introduction members (6) and interposed between a tank (1) for said second fuel positioned upstream of said regulator means (11) and at least one conduit (5) to which said introduction members (6) are connected, said regulator members (11) acting on the flow of said second fuel entering said at least one conduit (5) connected to said introduction members (6) so as to regulate its density and pressure and hence its mass flow, said regulation enabling the introduction into the explosion chambers of a quantity of second fuel (Q_e) stoichiometrically equivalent to the

quantity of first fuel (Q_b) required to achieve stoichiometrically correct engine operation or operation within predetermined parameters controlled by the single fuel feed control unit (8) provided in the system, said stoichiometric equivalence (Q_b , Q_e) of the first and of the second fuel enabling their times of introduction into the explosion chambers to be maintained equal.

3. A system as claimed in claim 2, characterised by comprising a single conduit (5) common to all the second introduction members (6) downstream of the regulator means (11).

4. A system as claimed in claim 1, characterised by comprising a plurality of conduits (5) which are each connected to at least one introduction member (6) and are positioned downstream of the regulator means (11) to feed the second fuel to said introduction members (6).

5. A system as claimed in claim 1, characterised in that the control means are a pressure regulator member (11) arranged to modify the pressure in each conduit (5) connected to the introduction members (6) so that the second fuel present in said conduit (5) has a density such as to enable a desired quantity of second fuel to be fed to said introduction members (6).

6. A system as claimed in claim 5, characterised in that the pressure regulator member (11) is a proportional solenoid valve having a valving element (17) arranged to act on the flow of said fuel through each conduit (5) to which the second introduction members are connected, said valving element (17) being controlled by an actuator (15) the operation of which is subjected to control means (21) at least on the basis of physical parameters related to the present conditions of said second fuel within said conduit (5) and of corresponding predetermined values of said parameters.

7. A system as claimed in claim 6, characterised in that the control means (21) of the pressure regulator member (11) determine further present parameters related to the engine operation during the introduction of the second fuel into its explosion chambers and act on said pressure regulator member (11) on the basis of a comparison of said present parameters with predetermined parameters.

8. A system as claimed in claim 6, characterised in that the physical parameters are the pressure and the temperature of the second fuel within the conduit (5) downstream of the pressure regulator member (11).
9. A system as claimed in claim 7, characterised in that the parameters related to the engine operation are at least the temperature of the cooling water (T_w) of the engine and the times at which the second fuel is injected into the explosion chambers thereof.
10. A system as claimed in claim 6, characterised in that the control means comprise at least one drive member (67) for the actuator (15) of the valving element (17) of the pressure control member.
11. A system as claimed in claim 10, characterised in that the actuator (15) is electrically powered, the drive member (67) acting on means (68) for interrupting said electric power (69) in order to control the operation of the actuator (15).
12. A system as claimed in claim 11, characterised in that the interruption means are a static switch (68), the drive member (67) being a voltage modulator, preferably modulating the duration of the command pulses of said switch (68).
13. A system as claimed in claim 6, characterised in that the control means (21) comprise a microcontroller (64) cooperating with a memory unit (63) in which predetermined values of the present controlled parameters are memorized, translation means (60, 61) for comparing the measured present parameters with their said predetermined values, and means (65, 66) for connection to an electrical processor external to the system, which is arranged to feed the said predetermined values into said memory unit (63).
14. A system as claimed in claim 13, characterised in that the translation means comprise filters and an analog/digital converter (61), the connection means comprising a UART block (65) and a logic gate (66).
15. A system as claimed in claims 6 and 11, characterised in that the control means (21) cooperate with reference generator means (75) and with a pulse sequence generator member (76) connected to the interruption means (68).

16. A system as claimed in claim 15, characterised in that the reference generator member (75) comprises means for evaluating existing operation macrostates of the engine and means for evaluating existing operation states of the engine, said macrostates comprising engine warm-up and its steady-state operation, the operation states being internal to each macrostate and comprising the constant operating conditions state (90), the acceleration transient state (91), the release or deceleration and/or braking state (92), the feed cutoff state (93) if the engine operates at high r.p.m. or with the pedal released, the state (94) of reentry from said feed cutoff state (93) and the state (95) of reentry from said feed cutoff state (93) followed by an acceleration transient.

17. A system as claimed in claim 1, characterised in that means (23) are positioned between the single control unit (8) and the second introduction members (6) for the second fuel to increase the intensity of the current absorbed by said second introduction members (6) compared with the current generated by said control unit (8).

18. A system as claimed in claim 17, characterised by comprising, for emulating the impedance of the first introduction members (26) for the first fuel, a circuit (24) interposed between the control unit (8) and said means (23) for acting on the intensity of the current fed to the second introduction members (26).

19. A method for feeding, and for controlling the operation of, an internal combustion engine fed with one or other of two different fuels, said engine presenting for the first fuel a plurality of first introduction members (26) and for the second fuel a plurality of second introduction members (6) connected to its explosion chambers, the first introduction members (26) being commanded and controlled in their operation by a control unit (8) which operates in accordance with predetermined parameters relative to particular optimum engine operating conditions, with said predetermined parameters there being compared corresponding present parameters measured during the engine operation, said unit acting on said first introduction members (26) on the basis of this comparison in order to modify the characteristics of the fuel introduction into the

explosion chambers whenever the present parameters indicate incorrect engine operation, said control unit (8) also controlling and commanding the second introduction members (6), characterised by providing for:

- a) the control and regulation of at least one physical characteristic of the second fuel fed to said second introduction members;
- b) on the basis of said control and regulation, feeding said second fuel to said second introduction members (6) in a quantity (Q_e) equivalent for oxidoreductive purposes to the quantity (Q_b) of the first fuel so as to maintain the times of introduction of said second fuel into said explosion chambers equal to the times of introduction of the first fuel into said explosion chambers, this enabling the control unit (8) to command said second introduction members (6) with the same mode of activation used to command the aforesaid first introduction members when under the same engine utilization conditions.

20. A method as claimed in claim 19, characterised by controlling the density of the second fuel fed to the second introduction members (6) so as to control its mass flow, i.e. the quantity which reaches and leaves said second introduction members (6).

21. A system as claimed in claim 20, characterised in that the density of the second fuel is controlled by controlling and regulating the pressure in at least one conduit (5) in which the second fuel is present and to which the second introduction members (6) are connected.

22. A system as claimed in claim 20, characterised in that the density of the second fuel is controlled by controlling the temperature of said fuel when it is present in at least one conduit (5) to which the second introduction members (6) are connected.